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ECO-FRIENDLY AUTOMOBILE BRAKE PAD USING LEMON PEEL

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ABSTRACT

In routine life, the most indispensable components were the polymers, throughout the past century, e.g., epoxy or poly-epoxide. The efficiency of organic fiber-based materials is assessed by performing a variety of research on the mechanical characteristics of epoxy-based reinforced composites, primarily concentrating on fibers as well as their percentage of weight within the composites. The purpose of the current research work is to discover mechanical characteristics of epoxy-based reinforced composites of lemon peel. The method of hand lay-up is employed to develop the composites that have a weight fraction of 5%, 10%, 20% and 30% of the peel of a lemon. As per the standards of ASTM for dissimilar experiments, the specimens of the fabricated composite were slashed. The assessment of density and hardness had been performed on the test specimens. The extreme bending, hardness, tensile, ILSS and density are attained by the preparation of material by the 20% epoxy-based reinforced composite lemon peel.

KEYWORDS: Lemon Peel; Testing and Performance; Mechanical Characterization & Hand Layup Method

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Original Article

1. INTRODUCTION

The composite material is formed through linking two or even several dissimilar materials through dissimilar qualities. This formed material is applied in brake pads.[1] The ingredients are united in a way that they retain their specific basic stages and are insoluble mutually or do not constitute a brand-new chemical compound. For this reason, the mixture is considered for every multi-phase system of material that shows a sequence of characteristics that develops the composite preferable to every constituent phase. The exploration and advancement of composite material are motivated through this criterion worldwide. The reinforcing phase and matrix are two categories of constituent material and the reinforcing phase is fixed through the matrix. The most important purpose of a matrix is to keep fiber to establish a specific shape. These also apply to transmit stress among the reinforced fibers and to safeguard them from the risk of damage of mechanical and environmental factors. In a matrix, the purpose of the reinforcing phase is to strengthen the mechanical characteristics like stiffness, strength and so on. As per refs. 2 and 3, the material of composite is to be designed such that a separate component retains their characters are so integrated that the composite exploits of their improved characteristics without including fragility of both. According to the employed matrix material, basically, three most important kinds of composite materials are chosen. The matrix material may be polymeric material, metallic substance, or can even be inorganic material. When the matrix is a polymer, the composite is called PMC. The FRP composite is the extremely ordinary

improved composite. This composite comprised of a matrix-based reinforced polymer along with lightweight out thickness fibers. The most common composite is employed for reasons like a lower price, better strength and simple processes of manufacturing. In composites of FRP, several resins of polymer systems are employed as matrices and categorized as a polymer of thermoplastics like PE, PP, nylon, and so on and thermoset like epoxy resin, PET, VER and so on. The polymer of thermoplastics can be softened multiple times and established by rising the temperature or strengthened by reducing the temperature, whereas the polymers of thermoset are infusible and unsolvable following cure.

As far as reinforcement is affected, fibers occupying the greatest fraction of weight in a FRP composite share their most important part of the load acting over the structure of composite. The reinforcing fibers can be orientated throughout fabrication, thereby providing an abundant prospect to the developer to make the features in a particular path. The glass, aramid and carbon are the most employed fibers in routine life[4] and[5]. In the recent times of exploration of engineering, importance has been given to old-style synthetic composite of fiber when compared to a lignocellulosic organic composite of fiber because of their benefits, such as specific strength-to-mass ratio, biodegradability and non-carcinogenic. The word organic fiber includes an extensive variety of animals, vegetables and fibers of mineral[6] and[7]. The convenience of organic fibers and easy production is attractive for researchers to test out locally accessible low-price organic fibers, as material reinforcement in the PMC. The other benefits correlated through organic fibers are the essential nature of nonabrasive, low-power consumption of energy, bio-degradable, lightweight and inexpensive[8]. The variety of reinforcement is chosen carefully so that it facilitates the characteristics of finished products that are customized to almost any specific requirement of engineering. Whilst the usage of mixtures will be a strong optimal in numerous examples, the selection of material in the remaining will subjected to factors like working requirements of lifetime, amount of items that will be formed like run length, a complication of form of product, probable savings in costs of assembly. The finest results have been attained through the usage of mixtures in conjunction with outdated materials[9]. The past research studied the properties of flexibility of the green compounds along with various fiber content of pineapple and associated with the virgin resin. The fiber of Sisal is relatively inflexible and coarse. It has great durability, strength, the capability of stretching, similarity for specific colorants and resistance to corrosion in marine water. The industries like marine, farming, shipment, and so on, employ the twines and ropes of sisal.[10] It is discovered that the fiber of sisal, palm and Agave four croydes have very same physical, tensile and chemical properties and wear properties[11] and performed a methodical analysis on the characteristics of the yellowish fiber of henequen and detected that all these fibers have mechanical characteristics that are appropriate for reinforcing resins of thermoplastic nature.[2],[12],[13] An experimental study on an incandescent wound fiber of cotton reinforced for reinforcing resin of high-density polyethylene,[14] examined the usage of the cotton fiber and reinforced composites epoxy along with glass FRP, examined the innovative variety of wood filler that is derived from OPWF for bio-based composites of thermoplastics by analysis of thermo gravimetric and the effects are very hopeful,[15,16]developed composites using the fiber of kenaf and jute and resins of polypropylene, and they described that fiber of jute provides superior mechanical properties when compared to the fiber of kenaf. An approximate 10% of waste fibers are produced throughout leaf defibration of fibers of henequen and the conversion of the raw fibers into cordage. Such waste fibers might be successfully employed in the development of composites of FRP because they acquire desirable mechanical and physical properties.[17]

2. MATERIALS AND METHODS

In this study, mechanical characteristics of epoxy-based reinforced composites of lemon peel had been discovered. Lemon

peel is used as an organic fiber, which is reinforced with epoxy-based composite. Raw materials and the dissimilar methods employed throughout this study are described in this section. The methods like measurement of density, micro hardness testing, and flexibility test. The materials are:

2.1 Lemon Peel

A lemon is one type of citrus acid fruit that primarily originated from the southeast part of Asia. This is the highest generally cultivated fruit tree worldwide. Like all citrus fruits, the lemon is acidic in nature and its range of pH is 2.9–4.0. The pulp, aromatic oils, proteins and some basic carbohydrates are comprised of the peel of a lemon. The peels of lemon were gathered locally and were dried in the sun for five days, so that humidity in the peels had been removed.

2.2 Epoxy Resin

Araldite LY556 is a type of resin of epoxy that is employed in this current study, which chemically belongs to a family of an epoxide. The common name of this resin is biphenyl-A-Diglycidyl-Ether. CIBA GUGYE India Limited supplies this type of resin.

2.3 Hardener

The hardener along with the International Union of Pure and Applied Chemistry nomenclature NNO-bis, i.e., DETA had been employed with epoxy defined as HY951. This has had a 10–20 MPa of viscosity at 77°F.

The methods are:

2.4 Measurement of Density

The density measurement of a substance is very easy because by the definition of density, one simply needs to specify the mass of the material on a specific volume. The method used to take measurements also depends on the level of the material.

2.5 Microhardness Testing

Micro hardness testing may be described as an indentation hardness testing. This method of testing is also known as the Vickers hardness test method. Mechanical engineering employs this testing for determining the toughness of material for deformity.

2.6 Tension Test

This test is also known as the tensile test and the most basic and shared types of mechanical testing. A tension test will apply stretching force to a material and estimate samples' reaction to the stress.

2.7 Bending Test

This test is also known as Flexural Test and employed to specify the bending modulus or strength of a substance. This test is more approachable when compared to tension test and results of the tests are somewhat different.

3. RESULTS AND DISCUSSIONS

3.1 Measurement of Density

Table 1 demonstrates that the percentage of a void fraction of a compound rises, as the percentage of reinforcement rises;

however, the corresponding substance of void is much smaller such that it displays that the manufacture of composite was performed appropriately. Figure 1 demonstrates the measured densities and the fraction of the weight of the composite. It should be noted that as the percentage of reinforcement rises in the epoxy, the density rises progressively up to 20.0% and unexpectedly reduces at 30.0% because the percentage of void rises the content of void and also because the percentage of the weight of fiber rises.

Table 1: Density of Dissimilar Specimens Find Measured/Theoretical/Volume Fraction of Voids Density (gm/cm^3)

Fiber Content (%)	Measured Density (gm/cm^3)	Theoretical Density (gm/cm^3)	Volume Fraction of Voids (%)
0	0.9	1.2	1.5
5	1.1	1.2	1.8
10	1.2	1.2	2.3
20	1.3	1.2	3.1
30	1.2	1.3	6.4

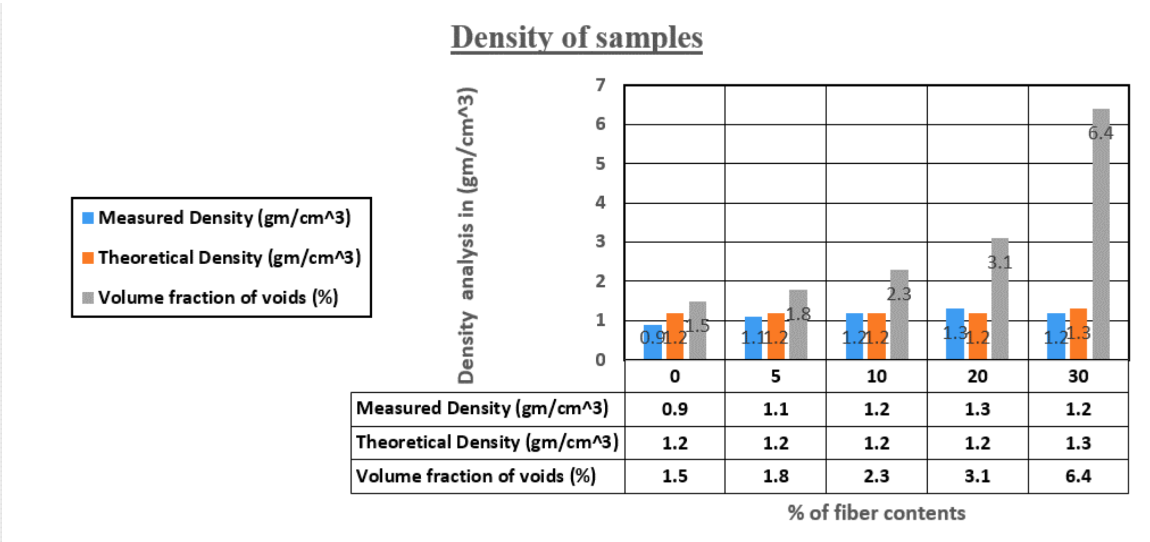

Figure 1: Dissimilarity of Density with Dissimilar Fiber Contents.

3.2 Micro hardness Test

A tester of Leitz Microhardness is employed to measure the number of Vickers's hardness. Table 2 displays the results. Figure 2 demonstrates the desired values of hardness and the percentage of the weight of a compound. It is detected that as the augmentation raises, the hardness and the extreme value is attained for a composite that is made by using the 20% compound.

Table 2: Hardness of Dissimilar Specimens

Weight Fraction of Particulates (%)	VH Value
0	19.694
5	19.18
10	20.78
20	21.12
30	19.86

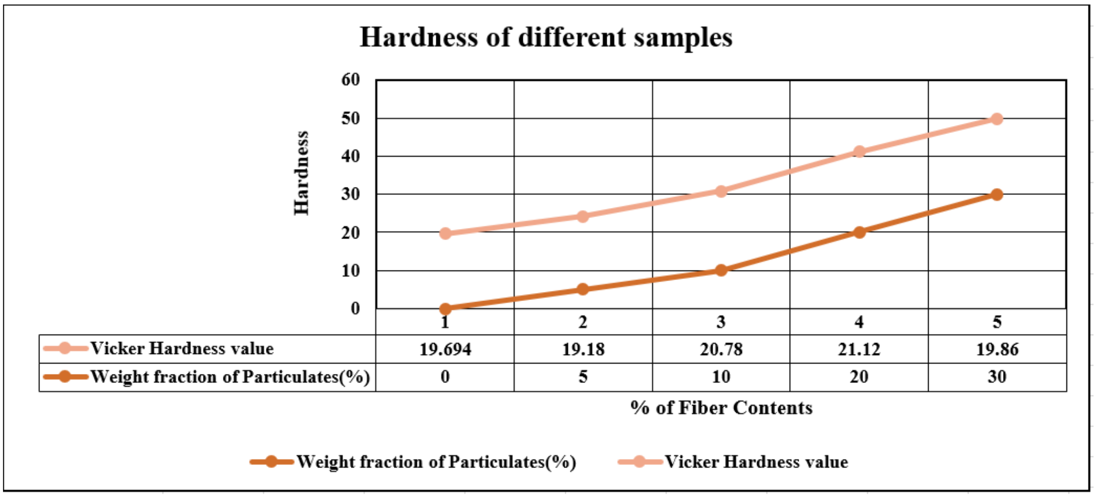

Figure 2: Dissimilarity of HV Value with dissimilar Fiber Contents.

3.3 Tension Test

Table 3 demonstrates the findings of the tension test using UTM. From figure 3, it is detected that the UTS is extreme for the composite that is made by using 20% fiber; however, for 30% of a fiber composite f, the UTS reductions is due to the content of the void.

Table 3: Tensile Stress and Tensile Modulus of Composites

Weight Percent of Fiber	Tensile Stress (MPa)	Tensile Modulus (MPa)
0	19.21	650.21
5%	19.25	745.12
10%	21.59	1234.73
20%	36.65	1162.59
30%	22.44	1038.34

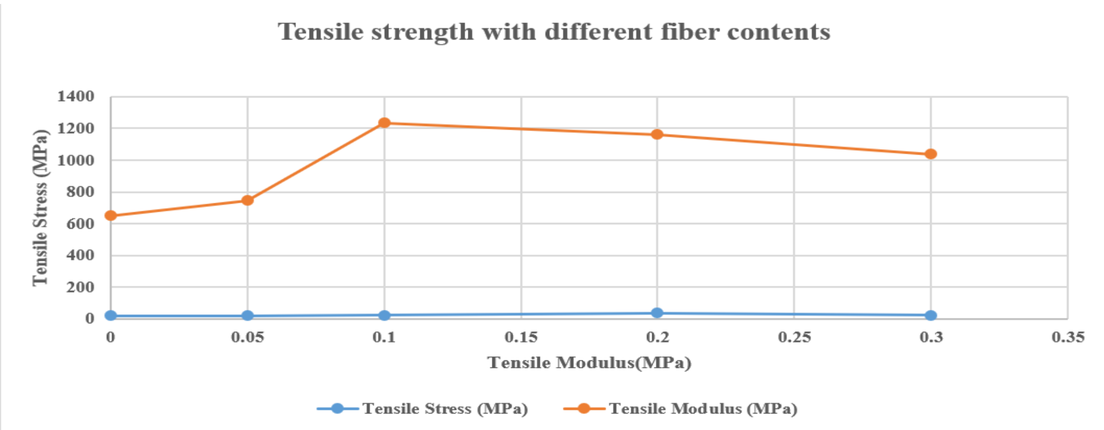

Figure 3: Dissimilarity of UTS with Dissimilar Fiber Contents.

3.4 Bending Test

The 3-point bending test was performed in the machine of UTM 201 as per the ASTM D2344-84. so that the bending strength of the compound is measured. Table 4 lists the values of modulus of rupture, bending modulus and interlaminar shear strength and displays that the compound with 20.0% substance of fiber has the greatest values of bending strength,

bending modulus and interlaminar shear strength. Figure 4 demonstrates the values of ILSS are becoming more extreme for the composite that is made by using 20% fiber.

Table 4: Bending Characteristics of the Composites

Weight Fraction of Particulates (%)	Flexural Strength (MPa)	Flexural Modulus (GPa)	ILSS (MPa)
0%	46.619	6.046	1.212
5%	50.21	5.146	1.523
10%	57.21	10.31	1.621
20%	63.21	11.21	1.911
30%	58.21	9.21	1.899

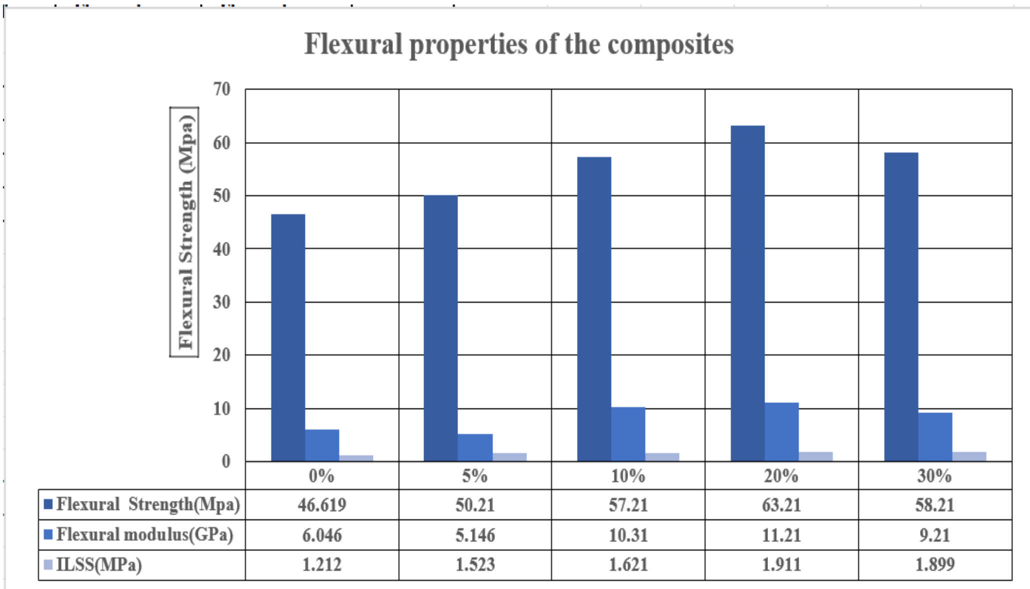

Figure 4: Dissimilarity of Interlaminar Shear Strength with Dissimilar Fiber Substances.

3.5 Scanning Electron Microscope Analysis

SEM of the test specimen of resin and its corresponding composite materials were chosen on Leo 435 VP. Figure 6 demonstrates the micrographs of the 20.0% epoxy-based reinforced composite of the lemon peel which depends on tension test. Micrograph demonstrates clearly that without debonding, without chipping out of fiber and without the formation of crack and also the bonding is powerful among the matrix and augmentation.

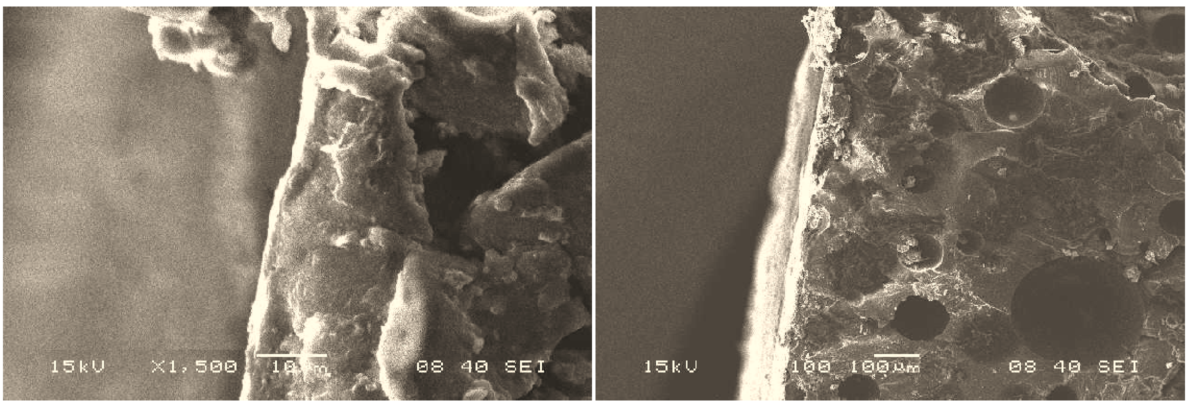

Figure 5: Microscopic Images of 20% Lemon Peel Compound after the Tension Test.

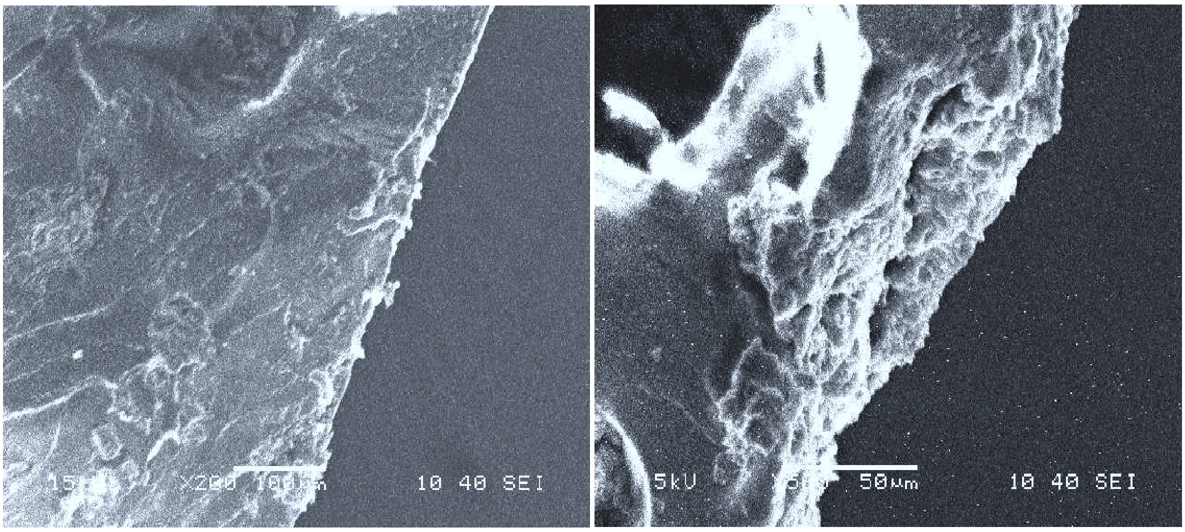

Figure 6: Microscopic Image of 20% Lemon Peel Compound after Completing the Bending Test.

Figure 7 demonstrates the micrographs of the 20% epoxy-based reinforced composite of lemon peel, which depends on the micrographs of bend strength that clearly displays that a few flexural fibers have occurred but the fibers will not be exiting the epoxy. This indicates that bonding is much more among the epoxy and fiber of lemon peel.

4. CONCLUSIONS

The current study discusses the formulation of the characterization of an epoxy-based reinforced composite of the fiber of waste lemon. The mechanical characteristics of the mixture result in these conclusions along with the effective fabrication of a newly discovered class of epoxy-based reinforced composite with lemon fiber. The ILSS and bend strength of compound are discovered to be extreme with 20% of wt% of lemon fiber. The UTS of the composite is discovered to be extreme for 20% of the weight of the lemon fiber. The value of hardness of the mixture rises through the rising of the fiber content. The observation of SEM exposes that the majority of the fibers were divided without withdrawing from the matrix. This suggests a decent bonding between the matrix and fiber.

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